Agricultural and Biosystems Engineering Technical Reports and White Papers

Agricultural and Biosystems Engineering

2005

Ammonia Emissions Rate from Composted Laying Hen Manure

Paul C. Harrison
University of Illinois at Urbana-Champaign

Ken W. Koelkebeck
University of Illinois at Urbana-Champaign

Hongwei Xin
Iowa State University, hxin@iastate.edu

Ammonia Emissions Rate from Composted Laying Hen Manure

Abstract
During the past five years we have developed three emission calorimeters (EC) that can be used to evaluate mass generation and utilization of gasses. We have tested various treatments that significantly reduced ammonia generation by laying hen manure (Harrison and Koelkebeck, 2002; 2003).

Disciplines
Agriculture | Bioresource and Agricultural Engineering | Poultry or Avian Science

Comments

Ammonia Emissions Rate from Composted Laying Hen Manure

P.C. Harrison*, K.W. Koelkebeck*, and H. Xin†

***Department of Animal Sciences, University of Illinois, Urbana, Il 61801**
and
†Department of Animal Sciences, Iowa State University, Ames, IA 50011

Introduction

During the past five years we have developed three emission calorimeters (EC) that can be used to evaluate mass generation and utilization of gasses. We have tested various treatments that significantly reduced ammonia generation by laying hen manure (Harrison and Koelkebeck, 2002; 2003).

In future research we are interested in evaluating the influence of some of the previously tested treatments on ammonia emissions from composted laying hen manure. Since many composting processes are managed on the same farm facilities as the animals that generate the manure, the ammonia produced by the compost may be attributed to the total allowable level allowed for the animal production unit. Since there is not an established method for obtaining samples for determination of gaseous ammonia emissions from a field source causing the emissions, the research herein compares ammonia emissions from samples of stored laying hen manure that were obtained and processed for evaluation with different techniques.

Materials and Methods

In a cooperative research project, ammonia emissions from samples of stored laying hen manure that was being studied at Iowa State University (ISU) were evaluated. Manure samples were collected using two different methods and ammonia emissions from the samples were analyzed in the gas emissions calorimeters (EC) at the University of Illinois (UI). The sampling methods were: (1) Scoop: Manure was scooped from the top six inches of the surface, and (2) Core: A core sample was obtained with an ESP soil sample probe[1] from the full (nine inch) depth of the stored manure. The second sampling method is a common procedure for obtaining soil samples.

In general, the manure was sampled out of two controlled environment chambers at the ISU experiment station and it had been stored for approximately forty days. During the forty-day storage period fresh manure was added at two-day intervals for the first two weeks of storage. One manure source (control) had no treatment other than the fresh manure additions. The manure from the second environmental chamber had been topically treated with zeolite.

[1] JMC Environmentalist's Sub-Soil Probe, Clements Associates, Inc., Newton, IA

Three scoop samples were taken from each of the two manure sources. Scoop samples were placed into six tubs (5"H x 7"W x 11"L) and a sealed cover was placed over the tubs for transport to the emissions calorimeters (EC), located in the Environmental Research Laboratory at the University of Illinois. Six core samples were taken from each of the manure sources. Core samples remained in the plastic tubes (36"L x 1"D) into which they were collected, and were capped on both ends as soon as they were obtained. All samples were transported to the UI and stored at 4°C until processed for evaluation in the EC.

Processing of the manure sample prior to determination of ammonia emissions were: scoop samples (open vs. sealed) were divided into six additional tubs on the first day following collection; half were stored without tops at 25°C and remaining halves were again sealed and returned to 4°C storage. Core samples (Tube vs. Weigh boat) remained in the sealed tubes at 4°C prior to determination ammonia emission rate. In general emission rate from the core samples were from the tubes with the top cap removed or from the manure removed from the tube into a plastic weigh boat. All samples were at room temperature (25°C) during evaluation in the EC. All of the tubes into which manure had been collected were shortened and recapped by cutting through the diameter of the collecting tube. At the time of emission determination the manure was approximately 8-10 cm from the uncapped end of the tube or even with the opened end.

Results and Discussion

On the day of sample collection at ISU, mean ammonia emission rate from the manure sources from which the samples were obtained was 2.2 mg/h/kg, 670 mg/h/m^2, or approximately 1800 mg/h. The same mean unit values for the samples in the EC at UI were 46.9, 470, and 13, respectively. Handling of the samples during the analysis process also affected ammonia emission measurements. Scoop samples that were open and stored in a 25°C environment had lower ammonia emissions levels than those that were sealed (254$\pm$30 and 543$\pm$63 mg/h/square meter [sq m or m^2], respectively). Length of time that the samples were open significantly reduced emission rate and there was a significant interaction between length of time that the samples were open and treatment with zeolite prior to taking the samples (day-one vs. day-three Figure-Table 1). Regardless of sample method used the zeolite treated manure had a higher ammonia emission rate (Figure-Table 2). It was interesting to note that the zeolite treated manure was 46% lower than the non-treated when measured at the source, and the non-treated was 43% lower than the zeolite in the samples. The zeolite treated manure had a pH of 8.24 and a moisture level of 61.22% and the non-treated manure had a pH of 7.70 and a moisture level of 68.88%. Manure pH and moisture were from the scoop samples that had been sealed and stored at 4°C for six days prior to measurement. Ammonia emissions from the opened-scoop samples were taken on day two and four after collection and on day seven for those samples that remained sealed and emission rates were 311, 195, and 543 mg/h/square meter, respectively. Since ammonia emission rates were greater for the sealed samples, apparently storage at 4°C didn't significantly reduce ammonia level.

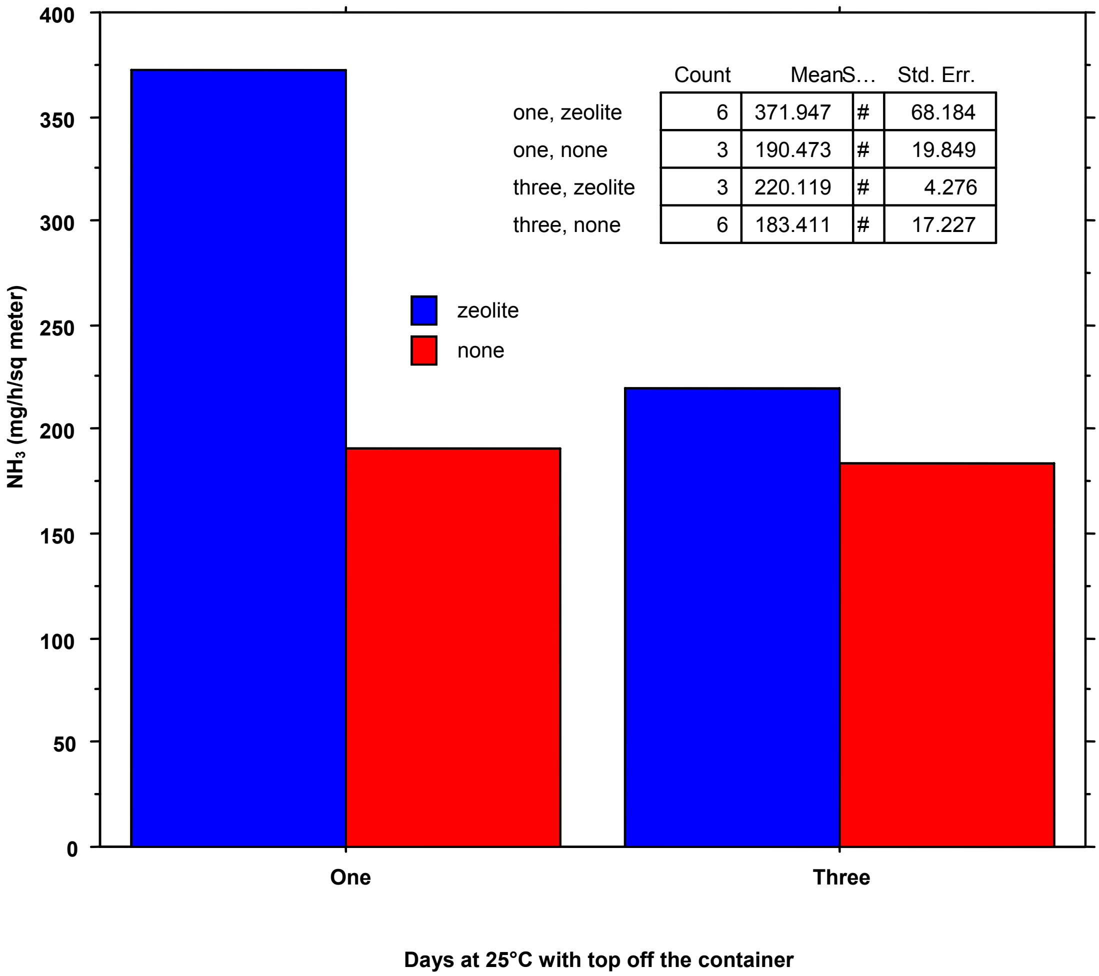

Figure-Table 1. Effect of open storage of laying hen manure samples at 25°C on ammonia emissions.
***Zeolite and none represent topical treatments of the manure source during the 40-day period prior to sample collection.**
****Mean ammonia values that differ by 105 mg/h/square meter are different ($P < 0.05$).**

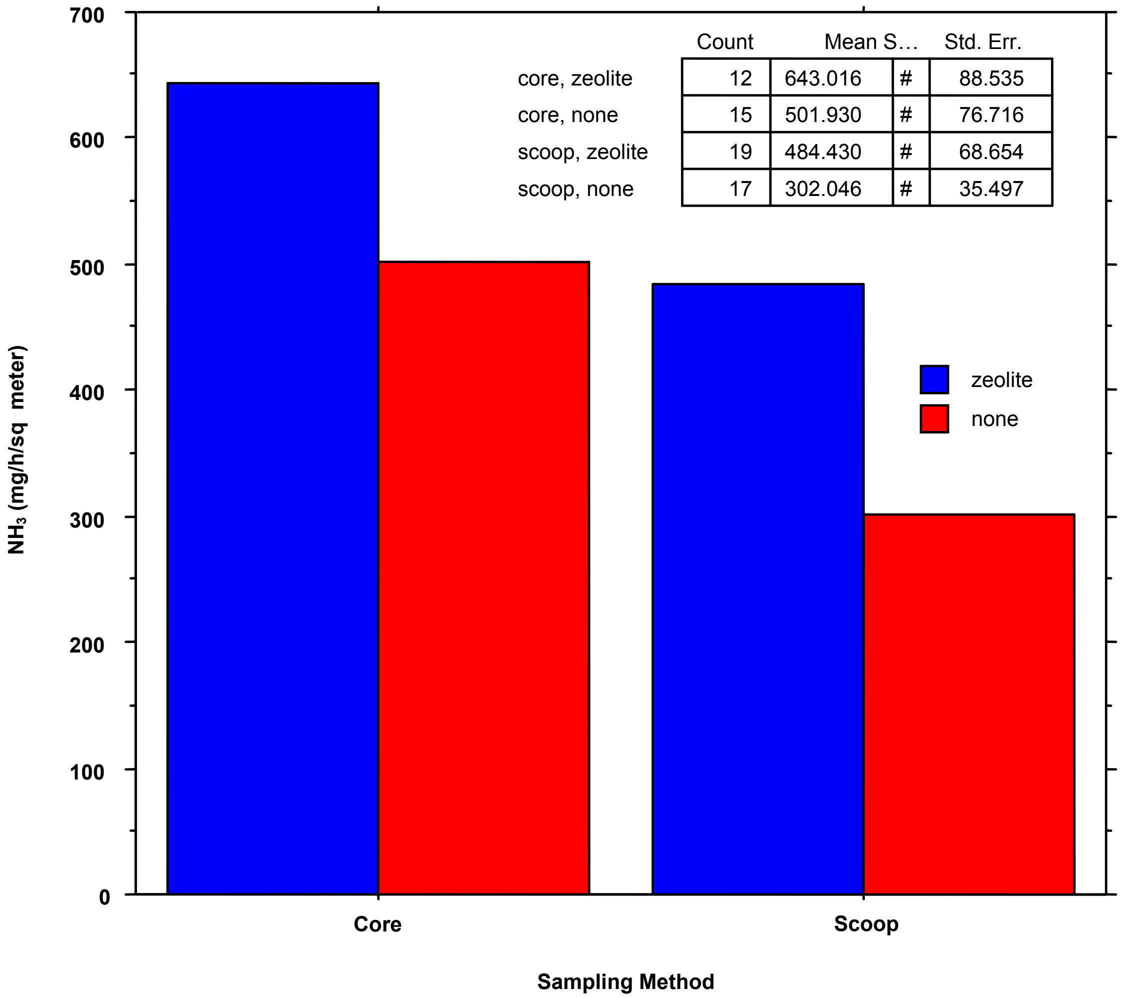

Figure-Table 2. Effect of sampling methods on ammonia emissions from laying hen manure.
***Zeolite and none represent topical treatments of the manure source during the 40-day period prior to sample collection.**
****Mean ammonia values that differ by 136 mg/h/square meter are different (*P* < 0.05).**

Laying hen manure samples did not accurately reflect ammonia emissions from the source from which it was collected. Expression of ammonia emissions from samples can be different from the source, which is probably related to variety of factors such as: mass, environmentally exposed surface area, time of exposure, and mixing or disruption of the profile of the manure source. Units used to express ammonia emission rate from manure need to be related to environmental impact rather than just in arbitrary values and units. These data clearly demonstrate the need for development of manure sampling methods that will allow for comparison of ammonia emission levels that are measured in field conditions to emission levels from samples evaluated in the laboratory. If environmental impact is the purpose of this type of research, these data demonstrate the need for establishing an evaluation system that relates eventual and total ammonia emissions from manure to replace arbitrary single-point and unit measurements.

References

Harrison, P.C., and K.W. Koelkebeck. Influence of application frequency of a topically applied manure ammonia inhibitor solution (AL^+Clear®) on mass ammonia generation rate. 6 pages in 2002 Annual Report, Northeast Regional Poultry Research Project, NE-127.

Harrison, P.C., and K.W. Koelkebeck. Mass ammonia generation rate from laying hen manure for three hours after a topically applied manure ammonia inhibitor solution (AL^+Clear®). 6 pages in 2003 Annual Report, Northeast Regional Poultry Research Project, NE-127.